Directional Drilling

Lakenheath CEs use trenchless technology to install piping underneath an emergency runway

by Capt Ted Munchmeyer, P.E. and Paul Briggs, *48th CES*

At most locations, utility installations and upgrades are projects that provide unique challenges to civil engineers. There are cost and time considerations, as well as ensuring construction services minimize environmental damage. These considerations only multiply when heavily populated areas or obstacles such as runways and taxiways must be crossed.

Meanwhile, the need for redundant and flexible utility services has become increasingly imperative. Anti-Terrorism/Force Protection (AT/FP) concerns are facilitating the drive to find cost-effective ways to provide uninterrupted critical utilities. This summer, the 48th Civil Engineer Squadron at RAF Lakenheath found an ingenious way to meet all of the latest AT/FP requirements while saving time and money on their latest water system piping project.

RAF Lakenheath is in the middle of a $4.3 million multiphase water distribution upgrade and expansion project for the vast majority of the base. The installation currently provides clean water for several thousand personnel, which equates to nearly 3 million gallons of water per day for various uses, including fire fighting capabilities and aircraft maintenance. To ensure water requirements can more easily avoid infrastructure AT/FP vulnerabilities, as well as allow routine maintenance to occur without disrupting service, RAF Lakenheath developed a ring main system around the operations section of the installation. Once completed, this new system will permit a redundant water supply to those critical operations with low-level maintenance piping that will last beyond 50 years.

The project required significant engineering analysis and flexibility by both the 48th CES and the selected contractors. It required installing more than 13 miles of 16-inch internal diameter high-density polyethylene (HDPE) pipe around the runways, roads and high traffic parts of the installation. This thick piping, which is rated at 100 psi, would be an excellent long-term material, allowing 100 percent deliverable water flow rates for critical items such as operational fire protection and aircraft maintenance.

Directional drilling uses a system of augers, pipes and Bentonite clay material to install pipe with little outward disturbance.

The Lakenheath project required installation of over 13 miles of 16-inch internal diameter high-density polyethylene pipe around the bases runways and high-traffic areas. *(Photos courtesy 48th CES)*

However, there were site conditions and operational restrictions making it difficult to simply install the piping. First, the RAF Lakenheath airfield has a very high groundwater table, and using open ditch construction for pipe installation would be difficult, if not expensive, to administer. Second, the piping needed to cross the emergency runway, and cutting through this thick combination of asphalt and concrete was an option the base command strongly wanted to avoid. Finally, air operations could not be halted — runways at RAF Lakenheath must be fully operational at a moment's notice. An alternative to the open trench method of installing the water main was needed.

Trenchless technologies have increasingly been accepted for construction in urban areas as well as difficult to excavate locations. There are several different methods of trenchless technologies, all with different benefits and limits to installing virtually any size or type of piping material.

One form of trenchless technology available at Lakenheath, called Directional Drilling, offered a solution to the problem of installing piping underneath the emergency runway. The main contractor, Balfour Beatty Ltd., subcontractor Trenchless Technologies Ltd., and 48th CES project manager Paul Briggs believed Directional Drilling offered the most advantages to completing the project and avoiding operational downtime.

This method involves using a system of augers, pipes and Bentonite clay material to install the pipe with little outward disturbance. It requires very little excavating and trenching as well as minimal pumping of groundwater, a slow and laborious process. The most important of all the positive benefits however was that installing 200 yards of piping underneath the runway could be completed in four working days, thus minimizing the possibility of disturbing airfield operations.

Upon site set-up, a 4-inch bladed directional bit attached to a hollow steel pipe was placed into the ground at a 45-degree angle. This bit proceeded at 150 to 250 revolutions per minute, cutting at a rate of up to 65 feet per minute to a depth of 20 feet. The directional bit was remotely controlled by a site worker who could locate and steer the bit in any direction, ensuring proper direction of the proposed line. Since soil conditions at RAF Lakenheath were favorable, the directional bit was easy to maneuver through the high silt/clay topsoil and onward through the soft chalk material 3 yards below ground level. Directional control was critical during the project since a large, 4-foot diameter storm sewer line crossed directly in the pathway of the new line. The operator could not afford an accidental "connection" into the storm sewer system.

A Bentonite clay slurry at a high pressure of 500 psi was pumped into the bit, providing a smooth lining for the pipe to follow. Approximately 200 yards away, the auger-tipped pipe arrived with full connectivity to the other side of the runway in less than four hours of precision drilling.

Once the 4-inch bit was free of the ground and the ground water that remained in the small tunnel was drained, a 30-inch diameter barrel boring bit was attached from the receiving side. This bit returned to the starting side via the route in which the 4-inch pipe was currently located. This new bit also increased the size of the tunnel to 2.5 feet in diameter, a size larger than the final pipe diameter. Bentonite clay was again inserted through the bit to ensure the tunnel would remain intact as well as expand to minimize water penetration from the surrounding ground water.

With the large tunnel now drilled, the HDPE was fed into the tunnel using the auger bit as a guide. The piping had already been fused together, so the entire 18-ton length was installed in one piece, minimizing potential for breakage and poor fitting. The installed piping was more than 2.5 inches thick; about twice as thick as the rest of the network since the depth and potential loading from incoming aircraft required a stronger pipe.

Paul Briggs, 48th CES project manager, inspects installation of Lakenheath's new redundant water distribution system.

The entire phase of the project took only four days for three operators to complete on 12- to 16-hour shifts, despite less than favorable weather conditions. Due to the latitude, long summer days allowed for such extreme scheduling to proceed without need for external lighting. Minimal equipment, including an HDPE butt-fusion jointer, backhoe and support trucks were the only vehicles necessary to install the pipe. The installation of piping under the runway, conducted over the long 4th of July weekend, avoided runway closure and ensured minimal disturbance of base operations and an upcoming NATO exercise.

Using new and innovative methods of design and construction, RAF Lakenheath will be able to have a redundant water distribution system at a cost much below previous estimates. If alternative methods of installing the pipe were used, the costs were estimated to have likely doubled or even tripled the final sum. It would have also required the runway to be closed, since locating the line in another location was not possible for AT/FP requirements.

Thanks to the dedication of the members of the 48th CES and its contractors, the spirit of providing excellent customer service with minimal impact to base operations has once again been proven.

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Trenchless Technology	Suitability	Limits
Directional Drilling	For polymeric or steel pipes and ducts on straight or curved routes in soft soils	4- to 48-inch pressure or gravity lines up to 1 mile in length
Auger Boring	Hydraulic driven non-displacement boring for pipes and casings	6- to 42-inch pipes for distances up to 200 yards
Rock Boring	Boring for steel casings in gravels, cobbles and solid rock	4- to 24-inch casings up to 175 yards; expensive
Impact Pipe Ramming	Install steel sleeves in various situations	6- to 64-inch sleeves up to 100 yards in length
Rod Pushing or Impact Moling	Best for installing small diameter pipes and ducts through hydraulic or impact methods	2- to 4-inch pipes and ducts under 25 yards in length